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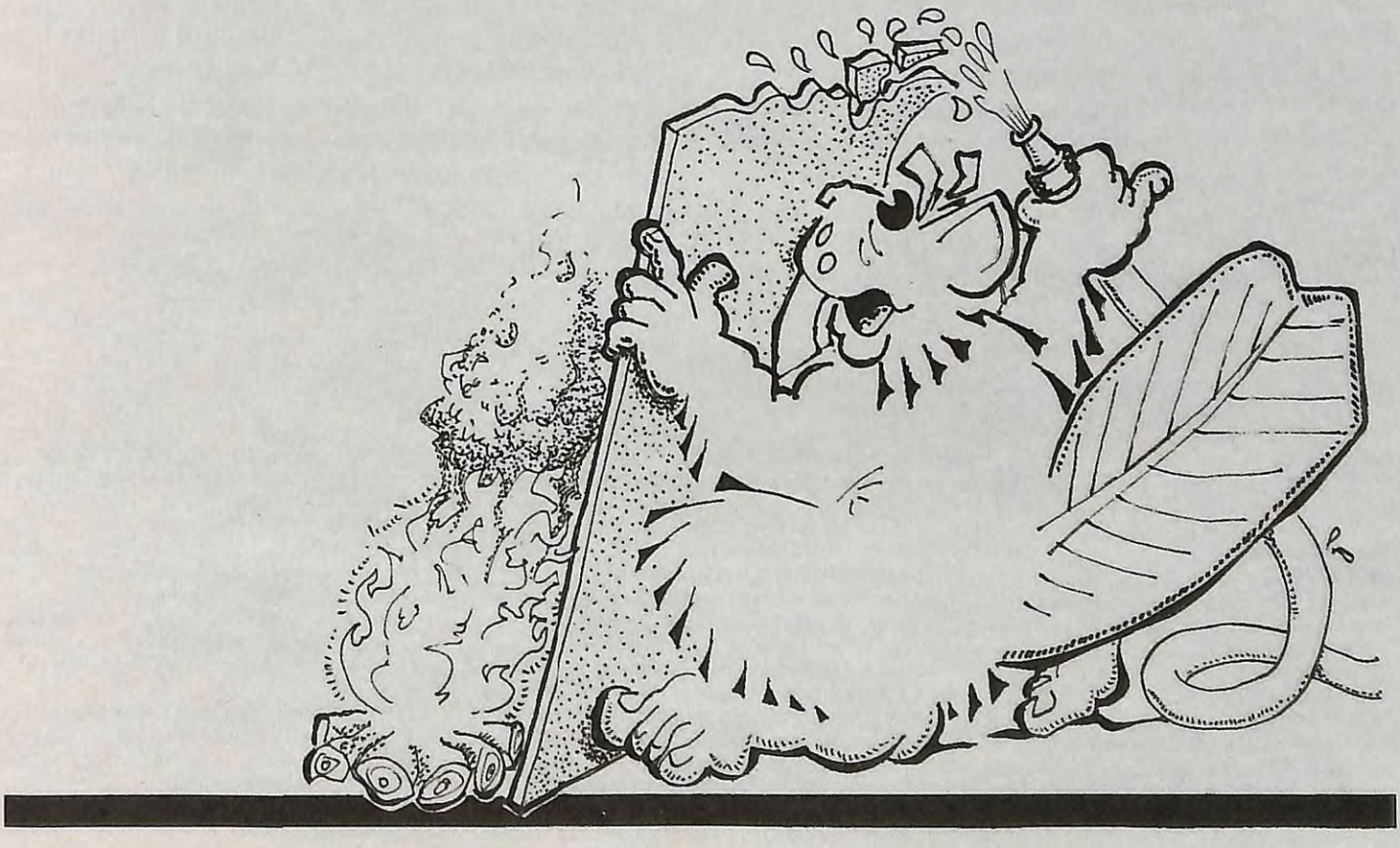
Drywall



From the Editor . . .

We are seeing increasing evidence of climate change. Detractors still try to attribute unusual climate events to the normal variability of the weather. The energy industry has their legions of lobbyists fighting to maintain the status quo for big oil, gas and coal. The policies of the US government and most other governments seem to be set by big oil. Canada is just swept behind in the wash.

However, the scientific evidence is unassailable that humans have had a major impact on the world's ecosystem. Everyday the evidence mounts about the consequences and what we may be seeing in the future. The insurance industry has recognized the seriousness of the issue. The Pentagon has recognized the military implications, and is quietly working to come to terms with the upheaval that we will be facing. The current best selling book *The Weather Makers* by Tim Flannery has spurred the Australian government to finally take the issue seriously. I hope it will have a similar effect on North American governments.

We are blinded by the big picture. If someone in government pockets $10,000 or spends $5,000 on lavish entertaining expenses, most of use are shocked and react. It becomes a big issue because as individuals we can understand and relate to an expenditure of $5,000 or $10,000. But when misguided actions cost billions, it is beyond the comprehension of most individuals simply because the numbers are so large.

The same applies to individual actions. It may not seem like a big deal when we jump into our car to go four blocks down the street to the corner store, or if we purchase the SUV that consumes 2 litres/100 km more than a more frugal model, or if we only use conventional lower efficiency furnaces and water heaters in our homes. But when multiplied over the millions of individual decisions, the consequences are a big deal.

In the housing sector, we often don't think about it, but decisions we make today for our customers, be they a custom home or for an unknown purchaser, set in train actions that will have repercussions for a long time into the future. Chief among these is the impact of the home's energy consumption, since buildings represent about 1/3 of total energy consumption, and thus contribute to greenhouse gas emissions.

The small but significant actions that have to be taken need to be done by us as individuals. We need to recognize that, taken cumulatively, our individual decisions and actions are what have created the ecological crisis we are facing, despite the denial of many decision makers. It will be individual action that will have to be taken to deal with the issue. Broader social policies are needed to help us move in that direction, and some of these may not be popular, such are finding ways to make our communities more efficient and curb suburban sprawl.

I am heartened to see that there is an openness in the industry to learn about opportunities for improving our product, and the long-term performance of housing. I would hope that at the same time everyone recognizes that applying green building and energy efficiency principles will not only improve the performance of the houses we build and renovate, but also make the homes more durable. And all of this can only help to lessen our impact on the environment.

Richard Kadulski,
Editor

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Drywall 101

Drywall: How it's made

Gypsum board is the most commonly used interior finish material in buildings today.

We largely take gypsum board for granted, although we should understand something about its properties. Gypsum board is the generic name for a family of panel-type products made of a noncombustible gypsum core with a paper surface on its face, back, and long edges.

Gypsum board, more commonly referred to as drywall or wallboard, differs from products such as plywood, hardboard and fibreboard because of its noncombustible core. It provides a monolithic surface when joints and fastener heads are covered with a joint treatment system. Available thicknesses vary, but the most commonly used drywall is about ½" (12.7 mm) thick.

Gypsum, the core material, is a common mineral found in sedimentary rock formations in many parts of the world. It is known as calcium sulfate dihydrate (for the chemists: $CaSO_4 \cdot 2H_2O$). One hundred pounds of gypsum rock contain approximately 21 pounds of chemically combined water. Gypsum rock is ground into a fine powder and heated to about 350 °F, driving off 75% of the chemically combined water in a process called calcining. The dehydration begins at approximately 80°C (176°F), but in a dry environment some dehydration can start at 50°C. The calcined gypsum is then used as the base for gypsum plaster, gypsum board and other gypsum products.

To produce gypsum board, the calcined gypsum is mixed with water and additives to form a slurry which is fed between continuous layers of paper on a board machine. As the board moves down a conveyor, the calcium sulfate recrystallizes or rehydrates, reverting to its original rock state. The paper becomes chemically and mechanically bonded to the core and is strong enough to use as a building material. In fact, the paper face is a major contributor to the structural strength of the drywall panel. The board is then cut to length and conveyed through dryers to remove any free moisture.

The manufacturing process was first patented in 1894. Today's manufacturing process is very similar to the original patent. Initially drywall was used as a backing for the application of gypsum plaster and it soon became a replacement for wooden slat lath. In the 1930s the product evolved into what we know today when the process for wrapping the board edges was developed along with joint materials.

Today, manufacturers also use "synthetic" gypsum as an alternative to natural gypsum ore. This is a waste by-product from other manufacturing processes; primarily the manufacture of titanium dioxide used in paint and the scrubbing of flue gases in coal-fired power plants. Other sources of gypsum are waste from the gypsum board manufacturing plants themselves and waste board from construction sites (both new and renovation), where the material is collected, reprocessed, and fed back into the board production cycle.

More than 40 years ago the gypsum industry began recycling newsprint and other paper to manufacture the paper facing of gypsum board. Today, nearly 100 percent of the fibre used in the manufacture of gypsum board face paper comes from newsprint and post-consumer waste materials.

Moisture, Mould and Gypsum Board

Gypsum board should not be exposed to high moisture levels for extended periods of time. Examples of high moisture levels include but are not limited to, exposure to rain, condensation, water leakage and standing water. Some board products exposed to these conditions may not need to be replaced, depending upon the source of the moisture and the condition of the gypsum board being considered for replacement.

Greenboard or blueboard is a water resistant

Water-resistant gypsum board is NOT WATERPROOF. It is NOT to be used in critical high humidity areas such as around tubs, steam rooms, indoor swimming pools, saunas, or showers.

Valuable sources for more information are available from the Gypsum Association www.gypsum.org

Water-Resistant Gypsum Backing Board for Ceramic Tile in Wet Areas (Ga-239-04)

gypsum board that contains additives in its core to provide water resistance. Its face and back paper are treated to limit water absorption. Although designed for use in humid areas, water-resistant gypsum backing board is not waterproof. Water-resistant gypsum backing board is not to be used in critical areas of high humidity such as around hot tubs, steam rooms, indoor swimming pools, saunas, or showers.

Water-resistant gypsum board used as a base for tiles in wet areas must not be foil-backed and must not be applied over a polyethylene vapour barrier. Where water-resistant gypsum backing board is the substrate for ceramic tile on exterior walls requiring a vapour barrier, the vapour retarder should be created on the face of the gypsum board by the application of a uniform skim coat, not less than 1/32" (0.8 mm) thick, of water based type I ceramic tile adhesive (ANSI A136.1) over the water-resistant gypsum backing board.

Allow the skim coat to set or cure before applying the adhesive bond coat and installing the tile. Tests by an independent testing laboratory conducted in accordance with ASTM E 96 dry cup method (Procedure A), determined an average water vapour transmission rate of 17 ng/Pa•s•m² for this application method, well below the code defined limit of a vapour barrier at 60 ng/Pa•s•m². On exterior walls where the tile covers less than the full wall surface a vapour barrier can be provided on the interior surface by applying a vapour barrier paint or primer over the area not covered by the tile.

The gypsum board must be positioned so that the paper-bound edge is adjacent to and ¼" (6 mm) above the rim of the shower pan or tub. The gypsum board must not be applied with a cut end or edge adjacent to the tub or shower pan lip or rim. The ¼" (6 mm) space between the paper-bound edge of the gypsum board and the rim of the shower pan or tub must be void and must not be allowed to become bridged by caulk or tile adhesive.

Concrete backer board (concrete reinforced with fibreglass) should be used where actual moisture is expected, such as tub and shower surrounds or steam rooms. Concrete backer board is typically used as the underlayment for ceramic tile.

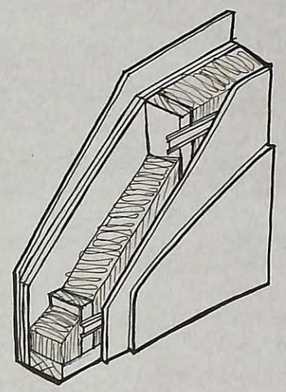
Mould

Because mould spores are present everywhere, mould can grow on practically any surface when conditions are favourable. Gypsum itself does not generate or support mould growth when it is properly transported, stored, handled, installed and maintained. However, the paper facing does have organic content that supports mould growth, which is why gypsum board must be kept dry to prevent mould.

If there is ever any doubt about whether to keep or replace gypsum board that has been exposed to moisture – replace it. ☼

*The gypsum industry has prepared an information piece titled **Assessing Water Damage to Gypsum Board** (GA-231-03).*

Acoustic Properties of Wood Frame Wall Systems



STC 59

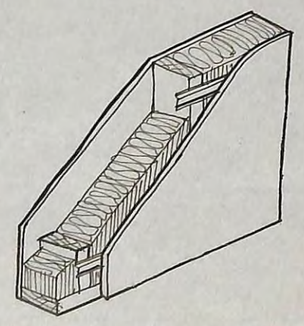
STC Rating of 59

Resilient channels placed 24" on centre and attached to one side of wood studs 16" on centre. A base layer of 5/8" type X gypsum board applied to the channels with 1" type S drywall screws placed 12" on centre. A face layer of 5/8" type X gypsum board applied with ¾" daubs of adhesive 12" on centre vertically and horizontally.

Opposite side: A base layer of 5/8" type X gypsum board applied with 5d nails 32" on centre. A second layer of ½" type X gypsum board applied with 8d nails 12" on centre. A face layer of 1/4" regular gypsum board applied with ¾" daubs of adhesive 12" inches on centre vertically and horizontally; 2" glass fibre insulation stapled to the 3-layer side in the stud space.

Penetrations through the wall and outlets in the wall must be sealed airtight.

GA File No. WP 3110.



STC 50

STC Rating of 50

Resilient channels placed 24" on centre and attached to one side of 2 x 4 wood studs 16" on centre. One layer of 5/8" type X gypsum board applied to the channels with 1" type S drywall screws placed 6" at horizontal joints and 12" on centre at intermediate channels.

Opposite side: One layer of 5/8" type X gypsum board applied to the studs with 6d nails 8" on centre. 3 ½" glass fibre insulation placed in the stud space.

GA File No. WP 3230.

STC Rating of 45

A base layer of ½" gypsum board applied to each side of 2 x 4 wood studs, 16" on centre with 5d nails 24" on centre. A face layer of ½" type X gypsum board applied to each side with 8d nails 12" on centre at vertical joints and 24" on centre at intermediate studs.

Noise Transmission Control

Homeowners today are demanding effective sound control capabilities in their new and remodeled homes. As the ambient noise of society rises, especially in urban areas, so do the concerns of consumers who want their homes to be a haven from noise produced outside and within their home.

Sound is generated by vibrations resulting in what are commonly referred to as sound waves. Sound can be airborne, structure-borne, or a combination of both. Airborne sound travels in the form of waves through the air such as those generated by speech or the whistle of a kettle. Structure-borne sound is created when a wall or floor is made to vibrate by direct contact with a mechanical device, such as a stereo speaker, washing machine, or footstep.

The most common type of noise is a combination of airborne and structure-borne. For example, a stereo speaker emits airborne sound and the speaker cabinet can be set in motion as the speaker reverberates, causing the floor to vibrate. The vibrating floor then transmits the sound to other rooms and floors in the same building. Airborne sound also travels through flanking paths such as any air leakage paths which could be at door and window frames and electrical boxes.

The amount of sound transmission that is eliminated by a construction assembly is referred to numerically as an STC rating (sound transmission class), and required minimums are set out in the Building Code. The higher the STC rating, the more effective is the system's sound-controlling abilities. An STC of more than 50 is considered very good.

A standard interior partition wall built of 2 x 4 studs with one layer of ½" gypsum board applied to each side has an STC of around 30. Higher STCs can be achieved by adding an extra layer of gypsum board. An STC of 50 is a minimum acceptable level for separations between apartments and townhouses. STCs over 55 are considered excellent.

Keys to Sound Control

- Increase the physical mass of the wall or ceiling by adding a layer of gypsum board.
- Decouple one side of the wall with resilient channels or staggered studs.
- Incorporate sound absorbing material into the wall cavity.
- Seal flanking paths.

A combination of materials is best to reduce noise levels because sound is made up of a wide variety of frequencies. Different frequency ranges are best controlled by different construction methods. Some frequencies are best controlled by more insulation; others are better controlled by the additional mass of gypsum board; yet others may be controlled more effectively by decoupling the structural elements that transmit sound.

Gypsum Board Wall & Ceilings Advantages

Gypsum board walls and ceilings have a number of advantages:

Fire Resistance

The noncombustible core contains chemically combined water that, when exposed to heat or flame, is slowly released as steam, effectively retarding heat transfer. Even after complete calcination, when all the water has been released, it continues to act as a heat insulating barrier. Tests conducted in accordance with ASTM E 84 show that gypsum board has a low flame-spread and smoke-density index.

Fire-rated (Type X) drywall was developed after World War II. It is formulated by adding noncombustible glass fibres and vermiculite to the gypsum, helping it to maintain integrity at high temperatures.

Gypsum board is the most commonly-used interior finish where fire resistance classifications are required.

Sound Attenuation

The mass of gypsum board effectively helps control sound transmission.

Durability

Gypsum board is strong with excellent dimensional stability and durability when used appropriately.

Economy

Gypsum board is readily available and easy to apply. It is an inexpensive wall and ceiling surfacing material offering a fire-resistant interior finish. Both regular and pre-decorated gypsum board may be installed at relatively low cost.

Versatility

Gypsum board satisfies a wide range of architectural design requirements. Ease of application, performance, availability, ease of repair, and its adaptability to all forms of decoration combine to make gypsum board unmatched by other products.

Moisture Problems in Seasonal Housing

Too much moisture in a house can be a big problem which can lead to unhealthy conditions and premature deterioration.

One source of moisture problems is condensation when temperatures are allowed to fluctuate. This is often noticed in electric baseboard-heated homes, when occupants turn down the heat in unoccupied rooms to reduce operating costs. If the temperature is allowed to drop too much, surfaces can be cooled to below the dew point, leading to condensation.

Moisture sources in homes occupied year round are generated by occupant lifestyles – cooking, washing and bathing as well as respiration. Measures to alleviate, eliminate and manage moisture loads have led to mechanical ventilation requirements that are now included in the National Building Code.

Seasonally occupied homes have moisture problems too and may be especially vulnerable to moisture issues. Seasonal homes are often located close to surface water, such as lakes, rivers or oceans, putting them in proximity to seasonally high water tables and flooding. They are also often located in or close by forests, reducing the drying effects of winds and solar radiation. Being seasonal, they are often built with less care and attention to proper construction practices, including foundation moisture management (which is often an issue in regular housing!).

Moisture problems in seasonal houses can provide lessons for homes that are occupied year round.

Anyone who has rented or stayed in a cottage over the summer can wax poetic about the sensory experience of cottage life, but can also give a fairly accurate description of the musty smell upon opening the cottage at the start of the season. That first whiff invariably leads to "airing out" – opening all windows and doors, possibly washing mouldy surfaces down. However, poetic and nostalgic these signs may feel, they can be detrimental to both the health of the building and of its occupants.

The source of moisture problems in seasonal houses is readily identifiable. The challenge is how to deal with high moisture levels.

Seasonally occupied houses are not necessarily built to the same high standards of year-round residences and are not generally kept up as well as year-round homes. Seasonally occupied houses are often built on less-expensive foundation systems. Open crawlspaces, dirt floors in shallow basements, poorly sealed concrete block construction can all lead to water infiltration. However, seasonal houses often may be used year round at some time.

A CMHC study set out to find inexpensive ways to reduce or eliminate the musty smell that is typical of seasonal houses. The field study looked at a small group of Nova Scotia seasonal houses. Each had an EnerGuide for Houses evaluation and an indoor air quality evaluation, and five were monitored over a two-year period.

Foundation problems were the major source of the moisture issues observed. In most cases, mitigating the foundation moisture problems would reduce the overall humidity levels in the houses.

Solving foundation moisture problems is not glamourous or groundbreaking. The fact all houses in the study had moisture problems that originated from the foundation was a clear indication that seasonal homeowners could improve the indoor air quality and the lifespan of their buildings by dealing with moisture problems in or around the foundation

Poor drainage and lack of eaves troughs or details to shed roof runoff away from the house would go a long way to improve indoor air quality in seasonally occupied housing. Unfortunately owners are often loath to spend their hard-earned weekends and vacation time working on a house or paying someone to do it.

Many seasonally occupied houses often have large expanses of glass to capture the view. In the shoulder and heating seasons, south-facing glass acts as a solar cooker for the building. Unshaded windows can cause temperature fluctuations within the building that are beyond the capacity of the air to hold moisture which condenses onto colder surfaces.

Key diurnal temperature patterns appear in November and from March on. These diurnal swings – highs above 10°C and lows approaching 0°C – are important in that they lead to house interiors reaching saturation or dew point temperatures frequently during these months, especially in wet fall or spring conditions when humidity levels are already high. March is noted as a month where this situation could occur on a daily basis, at least in Nova Scotia.

The contents of seasonally occupied houses can also add to the impact of moisture problems. Moisture is wicked from damp surfaces and absorbed through condensation by cardboard and other boxes. Furniture, draperies, books and other household goods can store large quantities of moisture, which can also be released throughout the unoccupied seasons.

Repairing the damage done by moisture problems if left unchecked can be more costly by far than dealing with the moisture problem itself. ☼

Investigating Moisture in Seasonal Housing *for CMHC Research Division, by Abri Sustainable Design & Consulting*

Air Leakage in Ducted Systems

The majority of Canadian houses have forced warm-air heating. These typically use sheet metal ducts in a variety of sizes and shapes depending on system size and layout. Duct sealing has never been a high priority for installers of forced warm-air heating systems. In most cases duct systems are placed entirely within the heated envelope of the house, so the assumption has been that the loss of energy due to incidental air leakage is not significant, even though inefficient duct layouts can lead to discomfort in some rooms.

However, measurements have shown that between 25 and 75 percent of the air moved by the furnace circulation fan may be lost through the system at duct seams, joints, elbows, etc. This means that as little as 25% of the design airflow could be delivered at the grilles where it is intended to go, hence cold rooms.

Duct leakage of such large proportions does have serious consequences. Not only can it lead to poorly heated rooms, but it can also create pressure imbalances between areas of the house. Pressure imbalance between floors, especially between the basement and main floor, is a common cause of carpet staining. Complaints of dust that are associated with forced warm-air heating systems are in part caused by air movements through construction cavities as a result of duct leaks.

Duct Leakage Tests in a Small Diameter Ducting System
for CMHC Research Division
By Dara Bowser, Bowser Technical Inc., with Doug Marshall, Marshall Consulting
Stephen Davies, Ecologix Heating Technologies Inc.

Flexible ductwork must be sized correctly. For properly balanced air flows, there must be a correct length of duct, which may mean extra ductwork needs to be installed as in this installation.

Numerous US studies on the sealing of metal ducts have shown that it is possible - with careful installation - to reduce the leakage level of regular metal ducts to less than 10%.

An alternative to traditional sheet metal ducting that has attracted some attention is the use of small diameter ducts with high velocity air distribution systems. These are proprietary systems developed initially as central air-conditioning retrofits for older homes, since these can be fitted into existing wall cavities and avoid the use of ceiling drops for ducts.

The small diameter ducts can be more airtight than the metal ducting, and leakage from these ducts will be minimal. For situations where it is critical to reduce duct leakage, small diameter systems can offer an advantage. They are now also being used in new homes for heating as well as cooling.

High velocity, small diameter duct systems are enticing to designers and homeowners because they avoid the use of large ducts and minimize the need for drops, but they do have some serious drawbacks, including increased noise due to higher airflow velocities, more fan energy required to move air through the more resistive smaller ducts, and the need for a properly engineered design for these systems. On the other hand, these small diameter systems are less prone to duct leakage due to the use of more airtight components and tighter junctions.

A CMHC study set out to determine how airtight these systems are in practice. Five houses with small diameter ducting were tested, each with the same proprietary duct system. These were systems that had been installed by different contractors long before any study was considered, so there was nothing unusual done to them to meet any duct leakage criteria.

The duct systems were found to have air leakage in the 3-9 percent range, depending on how the leakage was calculated. The results would meet, or come close to meeting most of the duct leakage standards in place in the US. In the US, duct leakage has been identified as a serious energy conservation issue because many heating and cooling systems have ducts that are located outside the heated envelope of the house.

The US EPA Energy Star Ducts standard allows a maximum air leakage of 8 percent of system flow.

Airtight duct systems are also important to duct system designers. A well designed system will include an allowance for duct leakage in its design calculations. A tight duct system will allow a more finely balanced system design. ☼

Quiet Exhaust Fans

Exhaust fans must be used if they are to provide effective air change. To remove odours or excess humidity, in most cases the fans have to run for more than the 30 minutes or so that most timer switches are set for (assuming that a timed switch is installed instead of a simple on/off switch). The major reason people don't want to have their fans running any length of time is because the fans are too noisy.

Dehumidistat controls were required for a time in BC by the building code. The requirement was removed because of complaints that the fans would come on during the night (when they are needed) and the noise was loud enough to wake the residents.

Today, the BC Building Code has the most stringent noise criteria in Canada for ventilation fans. It requires the principal fan, if operated intermittently, to have a sound rating not to exceed 1.5 sones, or 1 sone if operating continuously. However, even a rating of 1.5 sones is too noisy for many. The noise will be especially noticeable in a better insulated and air-sealed house that blocks out ambient noise, and at night when it is generally much quieter. By comparison, the National Building Code requirement for a principal fan is 2.5 sones.

The consequence of noisy fans is that homeowners disable them or don't run them when they should. I've observed builders placing a code-required principal fan in inappropriate locations, such a basement bathroom, so that the fan is further away from bedrooms and less likely to disturb sleeping occupants, but less likely to provide any level of effective ventilation.

Panasonic, makers of the quietest fans on the market, have re-engineered their products. The Panasonic WhisperGreen™ fans to be introduced this spring are a new line of quiet, energy-efficient exhaust fans with new variable speed DC motors. The high-efficiency DC motor is 30% - 70% more energy-efficient than previous models. All substantially exceed Energy Star criteria for ventilating fans.

The units are still being tested, so noise data from HVI are not available yet. However, the manufacturer's information shows that for an 80 cfm fan the noise level is 0.6 sones at 0.1 inch WG (25 Pa) and a power consumption of 13.8 W (or 6.1 cfm/watt). There is some drop-off as static pressure increases.

The variable speed control on these fans allows them to run continuously at a pre-set lower level depending on the unit (it can range from 30 to 110 cfm). The fan then increases to a maximum of 110 cfm when the switch is turned on or an optional integrated motion sensor is activated. A delayed off-timer returns the fan to the minimum cfm level after a period of time set by the user.

The fan is designed to perform at a constant airflow, which was nearly impossible until now because of duct length, elbows and other factors that hindered its ability to perform at rated levels. When a WhisperGreen fan faces static pressure, its speed is automatically increased to ensure that the desired cfm is maintained. This allows the fan to perform as rated and, more importantly, makes for easier installation because the installer no longer has to worry about compromising the fan's performance. ☼

Information
Panasonic Canada Inc.
www.panasonic.ca/English/ventilationfans

What is a Sone?

The sone is an internationally recognized unit of loudness, which simplifies reporting of sound output. The sones translate laboratory decibel readings into numbers that correspond to the way people sense loudness.

Sones follow a "linear" scale. Double the sone is double the loudness. Sone readings offer easy, quick and accurate comparisons. One sone is equivalent to the sound of a quiet refrigerator in a quiet kitchen.

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Points to Consider When Evaluating Fans

When evaluating fan performance, you need to consider:

- fan noise
- static pressure
- airflow, and
- power consumption.

Most fan airflow ratings are based on a static pressure of 0.1" WG (25 pascals), which essentially means with no pressure on the system. However, when a couple of elbows, a length of duct and a screened hood are added, the system is often operating at a static pressure of 0.2" or higher. That is why performance at a higher static pressure must be considered when selecting fans.

Power consumption should be considered on the basis of the airflow per watt (cfm/watt).

Noise ratings are measured for surface mounted fans (wall or ceiling). Remote located fans, such as an inline fan or a heat recovery ventilator, are at a distance from the exhaust grille, and sound is attenuated by the ducts, which is why it is not meaningful to measure and test sound ratings for these fans.

Fan	Airflow (cfm)	static pressure (" WG)	sones	watts	cfm/watt
Broan DX90	80	0.1	2.5		
	70	0.2			
Broan QTE090C	90	0.1	1	27	3.33
	68	0.25		27	2.51
Broan QTRE110C	110	0.1	1	37	2.97
	99	0.25		37	2.67
Nutone QTXEN080	80	0.1	0.3		
	68	0.25			
Nutone QTXEN110	110	0.1	0.9		
	96	0.25			
Fantech FX4 (in-line)	101	0.125		19	5.31
	86	0.25		19	4.52
Fantech FX5 (in-line)	115	0.125		19	6.26
	98	0.25		19	5.15
Panasonic FV05VQ3	50	0.1	< .3	12.9	3.87
	31	0.25		12.9	2.40
Panasonic FV08VQ3	80	0.1	0.3	22.8	3.50
	58	0.25		22.8	2.69
Panasonic FV11VQ3	110	0.1	0.8	30.7	3.58
	94	0.25		30.7	3.06
Reversomatic QFC80ES	58	0.1	0.5	22	2.63
	37	0.25		22	1.68
Reversomatic QFC130ES	108	0.1	1.5	29	3.72
	90	0.25		29	3.10
Reversomatic QFC150ES	135	0.1	1	27	5
	116	0.25		27	4.29

R-2000

For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

Representative air flows for HRVs. HRVs are designed to operate continuously, and recover heat from the exhaust stream. The heat recovery aspect is not captured in these numbers.

Fan	Airflow (cfm)	static pressure (" WG)	sones	watts	cfm/watt
HRV Venmar VanEE 99H	119	0.4		124	0.95
HRV Nu-Air NU-145	94	0.3		179	0.52
HRV Lifebreath 95 MAX	64	0.3		82	0.78
HRV Lifebreath 155 MAX	117	0.4		78	1.51
HRV Venmar 3055 Compact	115	0.4		97	1.18
HRV Venmar HE 1.8	151			184	0.82
HRV Constructo 1.5	119			124	0.95

You Asked Us: About Earth Tubes

Why are we not looking at earth tubes in Canada? A Swedish study, where temperatures go as low as -5 °C, showed that an earth tube could save 1200 kWh in a year while its fan used only 262 kWh. Shouldn't we be considering this idea in Canada?

The earth tubes you are referring to are pipes placed in the ground, through which ventilation air is introduced into the house, preheated by the relatively moderate temperatures in the soil. It is an idea that has been considered in Europe for a number of years.

The earth tube is a theoretically simple idea that can avoid excessive reliance on mechanical equipment, although fans to move the air are still required. Soil temperatures are fairly stable, but they do fluctuate over the year depending on the severity of the climate. The colder the climate, the more the soil temperature falls in winter, and so the more limited the potential.

The Swedish study you refer to (by Fredrik Ståhl, a professor at Chalmers University of Technology in Göteborg, Sweden) was a theoretical study with theoretical savings. Numerical calculations can be done, but there are some very practical issues that are not factored into the energy calculations. The full impact and actual performance of an earth tube installation must look at these other issues, and this was identified but not considered in the study.

It is not a good idea to collect fresh air at ground level, since there is much dust, pollen and other contaminants at grade. CSA F326 (the mechanical ventilation standard) requires the fresh air intake to be at least 18 inches above grade. That would require building a housing of some sort to protect, screen and perhaps filter the air intake, which would be located out in the yard, away from the house.

High relative humidity conditions in the earth tubes for long periods of the year are inevitable, especially in the warm seasons, at which time the soil temperature could be at or below the dew point of the air, leading to condensation in the earth tube. This would create ideal conditions for mould growth.

CMHC is doing some monitoring of this idea at the Canadian Centre for Housing Technology in Ottawa and on the Seabird Island community in the Fraser Valley east of Vancouver where earth tubes have been installed. However, the mould, condensation and cleaning issues are likely to work against the idea.

Earth tubes and passive stack ventilation were incorporated in several schools in Sweden. They found mildew growth on the tubes within a short period of time. ☼

Regulating Heating Systems

In Canada, authorities use various approaches to ensure that heating, ventilating and air conditioning systems are designed and installed properly in new residences. Some authorities require that heat loss/gain calculations and duct designs be submitted before they will issue a building permit, while others make no requirements at all. Some jurisdictions have more stringent inspection procedures in place than others.

Many inspections focus on trade-specific items, such as gas hook-up for gas systems, piping connections for hydronic systems, and electric wiring for electric systems or controls, but little more than these. As a result, there is little certainty that the system as a whole will function properly.

Does it make any difference whether detailed designs are done before issuing a permit, or if there are stringent inspections instead? No matter how stringent the permit or inspection process may or may not be, results are not always guaranteed. A CMHC study looked at two different permit and inspection processes in two Alberta cities and found that there were significant deviations from code requirements in each city.

A more rigorous inspection procedure in one city made up in part for the less stringent approval process in the other. The study found that the other city did not necessarily enforce its own permit requirements, and that the building inspection process in both cities missed flaws in some installations.

Study Observations

Despite the inability of builders, contractors and inspectors to ensure code compliance, homeowners had few complaints about the quality of their installations. It appears that there is little difference in the performance and perceived comfort levels of installed HVAC systems in the cities studied. All systems were ducted, forced warm-air heating.

The National Building Code of Canada states that the capacity of residential heating appliances must be determined in accordance with CAC/CSA-F280-M, but many jurisdictions do not enforce this requirement.

Accepted furnace capacity is considered to be from 100% to 140% of the home's design heat loss. All but one of the test houses had furnaces within the acceptable range. Other studies have shown that heating systems are often greatly oversized, as much as 200% or more of the design heat loss.

All of the systems tested had lower supply and return airflow rates at the grilles/diffusers than design rates, indicating there was considerable duct leakage. In one city the systems were delivering air to the selected rooms at about 69% of design rates, compared to the other systems that were delivering air at an average of 44% of design rates.

Excessive duct leakage can lead to poor heat distribution, noticeable in houses that are spread out, leading to discomfort in some parts of the house. Pressures within the home can also be uneven, which can lead to potentially dangerous negative pressures in some areas and carpet staining in others.

The documents submitted by contractors in one city varied significantly in the amount of information included and in its format.

There are many potential benefits from a process that requires heat loss calculations and duct design at the permit stage. However, the information must be:

- complete
- presented in a consistent and readable format
- reviewed by an experience person such that deficiencies can be detected prior to the start of construction
- used by the inspector after construction to ensure that the system was installed as designed.

The Impact of Requiring Residential HVAC System Design Submittals on System Performance prepared for Canada Mortgage and Housing Corporation by William Crist, P. Eng.

Technical Research Committee News

ACQ: Alkaline Copper Quaternary Treated Wood

The introduction of ACQ pressure treated wood and issues of compatibility with fasteners and connectors has been a concern.

The Home Owners Protection Office of BC has issued the first in a series of bulletins designed to provide practical information on new technologies, research results, good building practices and emerging technical issues in residential construction to Licensed Residential Builders and others in the industry.

Copies of their new bulletin on ACQ and appropriate fasteners along with other related articles can be downloaded from the Research and Education section of the HPO's website at *www.hpo.bc.ca.*

Why CCA Treated Wood Has Been Removed

Questions have been raised why the use of CCA treated wood in residential construction has been stopped. The preservative treatment industry voluntarily moved away from CCA-C to alternative treatments, such as alkaline copper quaternary (ACQ) and copper azole (CA) in the beginning of 2004. They had to make a difficult decision after numerous concerns had been raised about the use of arsenic-based products in residential environments. Although some scientists maintain that CCA is perfectly safe, many studies have shown that there could be some leaching of arsenic contaminating the environment, and the arsenic could directly affect people.

A recent study in Alberta compared the concentrations of chromium and arsenic on the hands of children playing in four playgrounds built with CCA lumber, to four that were free of CCA. The results showed significantly higher levels on the hands of those playing in playgrounds with CCA lumber. The elevated levels of chromium and arsenic on children's hands could only be explained by direct contact with CCA wood.

National Building Code

The latest edition of the code is now ready, and provinces are taking appropriate steps for implementation of the document with any local variations. Since the NBC format and approach has changed to an objective-based document, plans are underway to provide training for code users. Unfortunately, the training will be developed provincially rather than nationally, so it could still be some time before training is ready, and users can take full advantage of the new code.

Canadian Home Builders' Association

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

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2005 National Building Code of Canada

The hard copy version of the National Building Code is now available. A CD version will be ready later this spring, and will contain background information, including all "intent" and "application" statements. These are required to take full advantage of the objective-based features of the code.

Every code requirement is linked to at least one of the four identified objectives: safety, health, accessibility, and fire and structural protection of buildings. It is interesting to note that an explicit statement has been made that the safety objective of the code is to limit the probability that, as a result of the design, construction or demolition of a building, a person in or adjacent to that building will be exposed to an unacceptable risk of injury.

The expectation is that most users will be relying on Part B of the code, which contains the "acceptable solutions" and looks very much like the current version of the code that has been updated and revised.

Decks

Decks, balconies, and verandas have now been defined as buildings, so that proper foundation footings are required.

Concrete

Reference is now made to the new CSA standard for concrete for residential construction (CAN/CSA-A438-00). This applies to ready-mixed concrete,

and will result in better, more durable concrete with increased strength. Water-cement ratio requirements replace slump measurement tests.

Termite Protection

Termite protection is now required in regions where termites are known to occur, which includes pockets of southern BC, Alberta, Manitoba and Ontario. With the changing climate, and northward movement of warm weather species, these areas are likely to grow.

In termite areas, either preservative treated wood, or increased clearance between the ground and wood materials is needed. Exterior insulated foundations must have a termite barrier through the insulation and finish materials.

Snow Loads

Snow load calculation is now based on 1-in-50-year snowfall. This harmonizes with the changes in Part 4 of the NBC. In practical terms this means very little change for most locations, except for Nova Scotia locations where snow loading will be about 8% greater.

Window Area

There are no minimum window areas required, however, there must still be a means of egress. Operable windows for egress must provide a clear opening, without requiring removal of any components, so that top hung casement windows with hardware at the bottom, and centre pivot swing windows that restrict free area may not be considered as egress units.

Stairs

Requirements now allow a total tread depth and tread height construction tolerance of 6 mm. The NBC now allows winders to turn 30° or 45° for a total of 90°. Angled landings are also permitted. Handrails are now required on both sides of all stairs and ramps, and a table sets out criteria for required loads the railings must support. Inside single-family dwellings, traditional railing constructions are acceptable.

Foundation Waterproofing and Soil Gas Control

Soil gas entry and waterproofing of foundations must be controlled by soil gas barriers in the floor or by a sub-slab depressurization system. The air barrier must be on the exterior of masonry walls. For earth-sheltered structures, the waterproofing must be continuous from the wall onto the roof.

Insulated Concrete Form Walls

New prescriptive requirements have been introduced for flat insulated concrete form walls, below and above grade. The requirements are limited to a maximum two-storey-high building, with a maximum 3 m floor-to-floor height single-family house.

Roofing

Code language now recognizes that elements like balconies, decks, exterior walkways, etc. can serve as roofs, so must be treated as such. Flat roofs and decks must slope (in 2 directions) away from walls and solid guards. If balconies or decks are supported at the outside by vertical posts, the initial slope must allow for shrinkage settlement so that a positive slope is maintained after framing shrinkage.

All wall-roof junctions, and similar junctions must now have flashings, including saddle flashings with end dams to deflect water away and outward from the building.

Cladding and Moisture Protection

The code now explicitly requires two planes of protection. The first is the cladding, the second is behind the cladding (i.e. the sheathing membrane) and a capillary break.

A "Moisture Index" has been adopted to identify regions of high moisture loads where a vented rain screen is required. Areas that fall into this category include all of coastal BC west of the Coast Mountains, southern Ontario between lakes Erie and Huron, the lower St. Lawrence River Valley, portions of the Gulf of St. Lawrence, all of Nova Scotia, Newfoundland island, and portions of New Brunswick.

Mechanical Ventilation

Designers and builders had problems meeting the ventilation requirements of the 1995 NBC because of the complicated nature of its prescriptive requirements. The code provides two options: ventilation installed in accordance of the CSA F326 (Residential Mechanical Ventilation Systems), or a prescriptive solution that has been revised. The prescriptive requirements call for exhaust of indoor air, outdoor supply, and distribution of air through the house.

The code requires a principal exhaust fan capacity based on the number of bedrooms in the house. For houses with more than 5 bedrooms, F326 requirements must be followed.

Exhaust-only ventilation systems are permitted where there are no spillage-susceptible combustion appliances, where radon is not an issue, and where there is forced warm heating, and there are also explicit requirements for make-up air for exhaust equipment other than principal fans.

Unfortunately, fan sound ratings are still unacceptably loud, as the principal fan can be rated at 2.5 sones, and bathroom fans can be 3.5 sones.

In a future issue we'll review the ventilation requirements in greater depth. BC will not be adopting this section, but will be tweaking the current BC Building Code requirements. Ontario also had significantly different ventilation standards, so the final Ontario Building Code version may well differ from the NBC.

Carbon Monoxide Detectors

Carbon monoxide detectors are now required in homes with fuel burning appliances or attached garages. A CO detector must be placed in rooms with solid fuel-fired appliances. They also must be placed in or near each bedroom.

Updated GreenSpec® Directory for Green Building Product Information

The 6th edition of GreenSpec® Directory of environmentally preferable building products has been published by Vermont-based BuildingGreen, Inc. The directory contains nearly 2,000 listings, which provide architects, building owners and builders with a source for green building product information.

With the rapid pace of change in building products manufacturing, over 90% of the listings have been revised. More than 200 product listings were added and 100 dropped. Products were dropped because they may have been discontinued, the manufacturing process has changed (reducing recycled content, for example), and those that fail to qualify under new, tighter GreenSpec criteria, which are regularly reviewed and upgraded.

Screening criteria can viewed and downloaded from the BuildingGreen.com website ("What Makes a Product Green?")

Unlike most other directories in the construction and design sector, GreenSpec does not charge for listings or the review process, and doesn't accept advertisements. The product research process is supported strictly by publication sales (the directory costs $89) allowing GreenSpec to maintain an editorial independence and a high level of integrity.

For more information on GreenSpec:
www.GreenSpec.com
Tel 800-861-0954
(outside the U.S. and Canada, call 802-257-7300).

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Energy Answers

Rob Dumont

Transportation is a big user of energy, but your columns have basically said nothing about how our dwellings could be better built to improve transportation efficiency. Have you any thoughts on this?

Here's a thought: "Bicycles"

Last summer my family and I visited Germany, which uses about one-half as much energy per capita as does Canada, and yet has a standard of living that is within 10% of Canada's on a purchasing power equivalent basis. One German feature that contributes to its energy efficiency is the use and encouragement of bicycles. A side benefit is improved health.

The table below shows an interesting relationship between bicycles and obesity for four rich countries.

Country	Bicycles per 1000 population	% travel by bike	% obese adults
USA	385	1.0	30.6
Canada	450	2.0	23.0
Germany	588	12.0	12.9
Netherlands	1000	28.0	10.0

Saskatoon Star Phoenix, Feb 2006

Of the four countries surveyed, the USA had the lowest bicycle population, the lowest % of travel by bike, along with the highest % of obese adults. The Netherlands had the best performance, with the highest bicycle population, the highest % of travel by bike, and the lowest % of obese adults. Canada unfortunately is much closer to the USA than to the Netherlands in terms of bike usage and obesity.

In the Netherlands, and also in Germany, the transportation system is much more bicycle friendly, with many dedicated bicycle lanes, bike racks, and bike storage spaces on buses and trains.

I can recall a recent US survey that found the more people drove their cars, the greater the likelihood of obesity. People who live in the suburbs, and are more dependent on car travel, are also more likely to be obese. The results of that survey are consistent with the bicycle study.

Another interesting statistic from the bicycle study was the relationship between bicycle usage and % of the Gross Domestic Product spent on health:

Country	% travel by bike	% GDP on health
USA	1.0	14.6
Canada	2.0	9.7
Germany	12.0	10.9
Netherlands	28.0	8.8

As can be seen from the table, greater bike usage is associated with lower spending on health.

What measures do you see at the housing level that could improve bicycle usage?

Most North American cities that I have visited are quite hostile to bicycle users. In addition, most of our houses, apartments and workplaces are also hostile or indifferent to bicycles. To get Netherlands levels of bicycle usage, an integrated plan involving transportation planners, housing and workplace designers will be needed.

At the housing level, a modest change could help with bicycle usage. How about encouraging the use of bicycles by attaching a "bike-port" to each dwelling at ground level? The bike-port would shelter the bikes from rain and snow, keep the seats from getting wet, and have a convenient rack that would readily allow the bikes to be locked.

Buy a bike, use it, and improve your health.

NRC·CNRC

NRC-IRC Research and Technical Support for Housing

By John Burrows and Jim Gallagher

The NRC Institute for Research in Construction (NRC-IRC) presented its annual report of housing activities for 2005 to the recent CHBA annual conference. This article presents highlights from the report

Building Envelope and Structure

Vacuum insulated panels (VIPs) filled with new high-performance thermal insulation, such as micro- and nano-porous materials, can be up to ten times more energy efficient than insulation materials of the same thickness currently used. However, their use in buildings in North America has been limited, partly because of concerns about long-term performance. NRC-IRC researchers are evaluating the short- and long-term thermal resistance of these high-performance insulation materials and systems. They will then test prototypes of nano-porous materials for use as the core of a VIP. Next, they will seek industry partners to manufacture VIPs and evaluate them for performance and field application.

Inadequate detailing and installation of windows often causes building envelopes to fail prematurely. NRC-IRC is testing various window/wall construction details to see how well they control water intrusion at the window/wall interface. A number of full-scale wall sections incorporating specific window types and wall cladding systems have been subjected to rigorous testing in simulated wind-driven rain conditions. A number of other systems remain to be tested.

As reported in the January issue of Solplan Review, a comprehensive report entitled Performance Guidelines for Basement Envelope Systems and Materials has been made available free on the NRC-IRC Web site. The report is the major outcome of the industry-supported basement research project completed several years ago.

A new building envelope project concerns research on energy-efficient and durable envelopes suitable for Canada's North. The work began with consultations with northern communities and the construction industry to identify technological issues, community needs, and climate parameters. The next step is to design and construct a number of building envelope assemblies, assess them in full-scale testing facilities, and follow up with energy and environmental impact studies. Results will be validated by monitoring the field performance of several assemblies. The final step will be to select the wall assembly with the best overall performance, install it in a test house and possibly in houses in northern communities, and monitor its performance over several years.

Indoor Environment

One of NRC-IRC's major projects related to the indoor environment in the past decade has been a long-term study to establish the emission characteristics of construction materials and assemblies. The research has produced a database of emission characteristics for 69 building materials commonly used in North America. Complementing the database is software called IA-QUEST, which can predict the concentrations of volatile organic compounds that would be released from building products, materials and furnishings planned for use in a space under specific ventilation rates and conditions.

Several ventilation-related studies are in progress. One is seeking to determine the relative energy efficiency and thermal comfort benefits that might be achieved by hydronic radiant floor heating in comparison with forced-air heating. This work, being carried out in the NRC-IRC two-storey test house, will also investigate any promising hybrid combinations of these systems. A related project will evaluate hybrid ventilation systems that use both passive and mechanical ventilation at different times of the day or season to improve ventilation and potentially reduce energy use.

A review of published information on sensor technology for demand-controlled ventilation was recently done to shed light on the reliability and cost issues that are preventing wider use of this technology.

Acoustics and fire researchers at NRC-IRC have worked together for well over a decade to evaluate the sound and fire performance of walls and floor assemblies. This work, which enjoyed widespread support from industry and govern-

John Burrows is an Ottawa-based consultant and technical writer. Jim Gallagher is Manager of Publication Services at NRC-IRC.

ment, saw the testing of hundreds of assemblies for sound insulation and fire resistance. The floor project, the more recent aspect of the work, has now been completed. Included in the outputs was software for estimating airborne and impact sound performance of floors with resilient metal channels and insulating material.

Acoustics research includes the complex problem of flanking sound transmission, also known as structure-borne sound transmission. Researchers have completed some initial research addressing the effect of sound transmission through the structural connections at the wall/floor interface. The next phase of the flanking work, involving problems typical of apartment and row housing construction, will be enhanced by the recent opening of NRC-IRC's excellent new flanking test facility.

Fire Safety

While the wall and floor project has been the biggest housing-related project for NRC-IRC fire researchers in many years, several other fire studies are underway. One concerns the fire performance of single-family dwellings. The tests involve fires that would be expected to occur in the basement of a two-storey single-family house. For the work, the research team built a three-level facility (representing a two-storey house with basement) in the large NRC-IRC fire research complex at Almonte, Ontario.

Another fire study is looking at the possible use of compressed air foam (CAF) fire suppression systems for the protection of housing in the North. Suppression options are few in the North because of limited water supply and limited access to municipal water systems. In carrying out this research, NRC-IRC is drawing on its many years of study with industry to advance CAF technology for large-scale applications. The current work includes laboratory studies followed by testing in a vacant house in the North.

Codes and Evaluations

The publication of the three new objective-based National Construction Codes in September 2005 has generated great interest in the many technical changes made in the codes since the 1995 editions. This has been evident in the attendance at NRC-IRC code seminars being held across Canada.

In addition to the ongoing technical and administrative support they give to code committees, NRC-IRC codes staff are working with industry on a number of issues, including efforts to develop a harmonized Canada-US. standard for windows and a ULC committee developing air barrier standards.

NRC-IRC's Canadian Construction Materials Centre (CCMC) has been active evaluating new plastic composite extrusion products being used more and more for balconies and decks. Another active area for CCMC evaluations is a new family of structural wood adhesives. The moisture management of cladding systems not presently prescribed in the National Building Code is the subject of an evaluation underway with the help of building envelope researchers.

Canadian Centre for Housing Technology

NRC-IRC is responsible for the management of research at the Canadian Centre for Housing Technology (CCHT). Recent projects include the testing of the first Canadian residential fuel cell. The fuel cell was successfully connected to the thermal and electrical systems of one of the research houses and successfully generated electricity for the house, exported electricity to the grid, and generated heat for water and space heating.

NRC-IRC acknowledges the support of its many housing research partners and collaborators, including industry and government. For more information, consult the full housing activities report at:

http://irc.nrc-cnrc.gc.ca/fulltext/nrcc48613/

Net Zero Energy Healthy Housing

Canada Mortgage and Housing Corporation (CMHC) is forging a partnership between Natural Resources Canada, Industry Canada, Environment Canada, the Net Zero Energy Home Coalition and the housing industry through the Net Zero Energy Healthy Housing (NZEHH) initiative to address the practical challenges of ensuring a clean environment and healthy future for Canadians by making low impact Net Zero Energy Healthy Housing a reality in communities all across the country.

The goal of the Net Zero Energy Healthy Housing initiative is a national residential design-build-demonstration initiative to challenge builder/developers across Canada to act as environmental stewards by building affordable, healthy, highly energy and resource efficient, grid-tied housing that produces as much energy as it uses on an annual basis, with low/no housing related environmental impacts on water, land and air, integrated within a sustainable community plan.

The objectives of the initiative are to:

- To reduce the energy and resource intensity of the Canadian housing sector;
- To ensure quality, healthy housing that mitigates household energy costs;
- To contribute to a clean environment and reduced greenhouse gas emissions;
- To foster growth of the renewable energy and sustainable housing industries in Canada;
- To develop Canada's next generation of value added exports for competitive international markets.

Builder/developer led interdisciplinary teams with housing expertise in: environmental architecture; high performance building; renewable energy systems; sustainable community planning; integrated Design Process project management; and marketing and promotion will be eligible.

Teams will have to follow an integrated design process to develop, construct, commission, demonstrate, monitor and evaluate low impact sustainable housing projects that meet the goals and objectives of the NZEHH initiative, and involving performance evaluation in 5 categories: Health, Energy, Resources, Environment and Affordability.

Six to twelve projects will be selected from all regions of Canada to receive support, involving:

- Expert assistance for the integrated design process;
- Technical, Marketing Research and Communications support;
- National recognition as a competition winner;
- Promotion as a leader in sustainable housing;
- Financial contribution of $50,000 per project to defray eligible costs;
- Assistance through regulatory framework;
- Partnership network lending credibility and confidence to builders and consumers; and
- Support beyond demonstration stage for future business opportunities.

The NZEHH expression of interest Application and Guidelines will be available on CMHC's website by the end of April 2006.

The deadline for submitting an expression of interest will be about 6 weeks after the Guidelines are made available. Further details regarding initiative requirements and submission deadlines will be included in the Application and Guidelines package.

To be notified when the Application and Guidelines are available, call 1-800-668-2642 to be placed on the mailing list for the Net Zero Energy Healthy Housing Expression of Interest Applications and Guidelines.

http://www.cmhc-schl.gc.ca/en/inpr/su/neze/index.cfm

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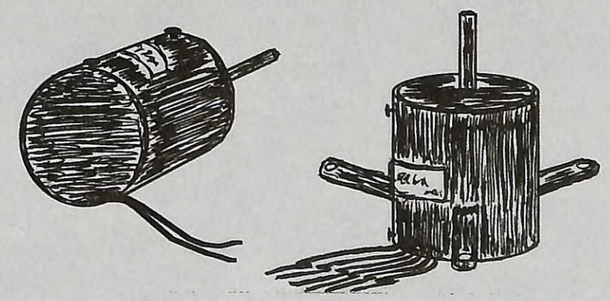

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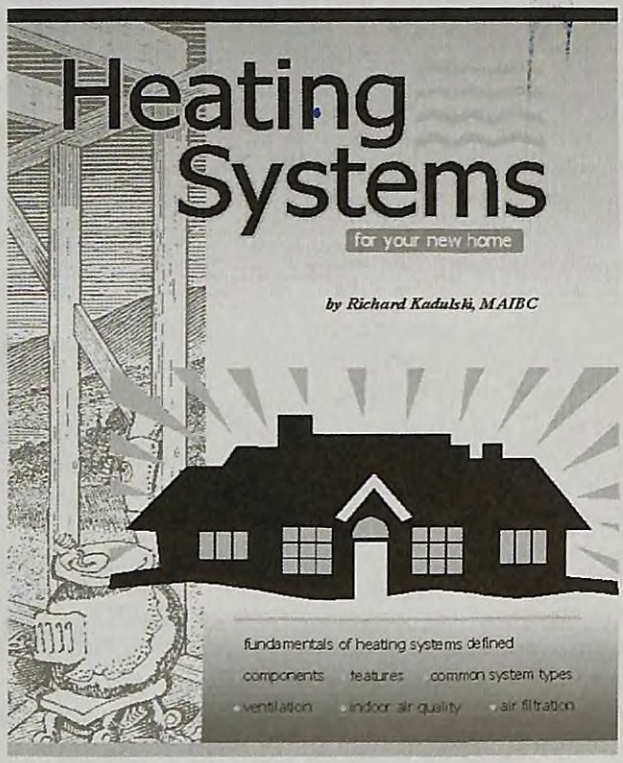
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